

Evaluation Of Yield And The Some Of Physiological Indices Of Barley (*Hordeum vulgari* L.) Genotypes In Relation To Different Plant Population Levels

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Abstract: In order to evaluation of yield and the some of physiological indices of barley genotypes (*Hordeum vulgari* L.) in relation to different plant population levels, a factorial experiment based on randomized complete block design was conducted in Research Farm University of Mohaghegh Ardabili in 2008. Factors were: plant population levels at three levels (400, 450 and 500 seed m⁻² with barley (*Hordeum vulgari* L.) genotypes at four levels (Lisive, Makoei, Sahand and 4714 line). The results showed that various levels of plant population affected yield and growth indices of barley (*Hordeum vulgari* L.) genotypes. Means comparisons showed that maximum grain yield was obtained to 500 seed m⁻². Barley genotypes had difference response to grain yield. Maximum grain yield was obtained in lisevi genotypes and minimum of it was in makoei genotypes. Investigation of variances trend of dry matter accumulation indicated that in all of treatment compounds, it increased slowly until 180 days after sowing with increasing of plant population and then increased rapidly till 278 days after sowing. From 278 days after sowing till harvest time, it decreased due to increasing aging of leaves and decreasing of leaf area index. Increase in plant population also significantly increased the crop growth rate and the maximum of it was observed by the plots that was applied 500 seeds per area with Lisive genotype. In addition, in all of treatment compounds, CGR increased slowly until 222 days after sowing and then decreased slowly till 236 days after sowing. From 236 days after sowing till harvest time, it decreased rapidly due to increasing aging of leaves and decreasing of leaf area index. Thus, it can be suggested that in order to increasing of grain yield, dry matter accumulation, crop growth rate and the other of physiological indices should be applied Lisive genotype with 500 seeds per area in conditions of Ardabil Plain.

Key words: Hordeum, Plant population, Physiological indices and Yield.

INTRODUCTION

Barley (*Hordeum vulgare* L.) is grown as a commercial crop in some one hundred countries world-wide and is one of the most important cereal crops in the world. Barley assumes the fourth position in total cereal production in the world after wheat, rice, and maize, each of which covers nearly 30% of the world's total cereal production (FAO, 2004). The yield of barley in Iran is very low as compared to other barley producing countries. One of the most important effective factors is non application of optimal plant population per hectare and barley genotypes differ in their response to plant density. In the other hand, plant density is one of the major factors determining the ability of the crop to capture resources. It is of particular importance in production of cereal such as barley, because it is under the farmer's control in most cropping systems (Satorre,1999). Optimum plant densities vary greatly between areas according to climatic conditions, soil, sowing time and varieties (Gate,1995). Consequently, there is value in defining relationships between density and barley yield to establish optimum seeding rates for various regions (Blue *et al.*, 1990; Anderson *et al.*, 1991; Campbell *et al.*,1991; Douglas *et al.*,1994; Qi-Yuan *et al.*,1994; Anderson and Sawkins,1997). Growth analysis is still the most simple and precise method to evaluate the contribution of different physiological processes in plant development. The physiological indices such as leaf area index (LAI), total dry matter (TDM), crop growth rate (CGR) and relative growth rate (CGR) are influenced by genotypes, plant population, climate and soil fertility (Murphy *et al.*, 1996). Weber *et al* (1966) founded that both total dry matter and leaf area index were poor predictors of grain yield. Dry matter production of crops needs on the amount of intercepting solar radiation and its conversion to chemical energy. When plant density is too high, it encourage inter plants competition for resources. Then crop net photosynthesis

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process will be affected due to less light penetration in the crop canopy as well as increase in the competition for available nutrient which will affect grain yield. On the other hand, application of optimum plant density helps for the proper utilization of solar radiation. Rao *et al* (2002) suggested that leaf area index (LAI) and leaves architecture are two main characteristics that define light interception in the canopy. Plant population modifies the canopy structure and influence light interception, dry matter production and crop yield (Fukai *et al*, 1990). Egly and Guffy (1997) reported that total dry matter is influenced by relative growth rate, crop growth rate and net assimilation rate. Crop growth rate is directly related to the amount of radiation intercepted by the crop (Jeffrey *et al*, 2005). Dwyer *et al* (1999) reported that increasing in population plant decreased leaf area index and net assimilation rate (NAR) per plant, but increased them in per area. Past researches show a variation in the responses of different barley varieties to plant population (Faris and De Pauw, 1981; Gate, 1995; Couvreur *et al*, 1999; Wiersma, 2002). The aim of this study was to evaluation of yield and the some of physiological indices of barley (*Hordeum vulgari* L.) genotypes in relation to different plant population levels in conditions of Ardabil Plain.

MATERIALS AND METHODS

In order to evaluation of yield and the some of physiological indices of barley genotypes (*Hordeum vulgari* L.) in relation to different plant population levels, a factorial experiment based on randomized complete block design was conducted in Research Farm University of Mohaghegh Ardabili in 2008. Factors were: different plant population at three levels (400, 450 and 500 seed m^{-2} with barley (*Hordeum vulgari* L.) genotypes at four levels (Lisive, Makoei, Sahand and 4714 line). Climatically, the area placed in the semi-arid temperate zone with cold winter and hot summer. Average rainfall is about 372 mm that most rainfall concentrated between winter and spring. Mean temperatures and rainfall for the 2008 wheat growing season is presented in Figure 1.

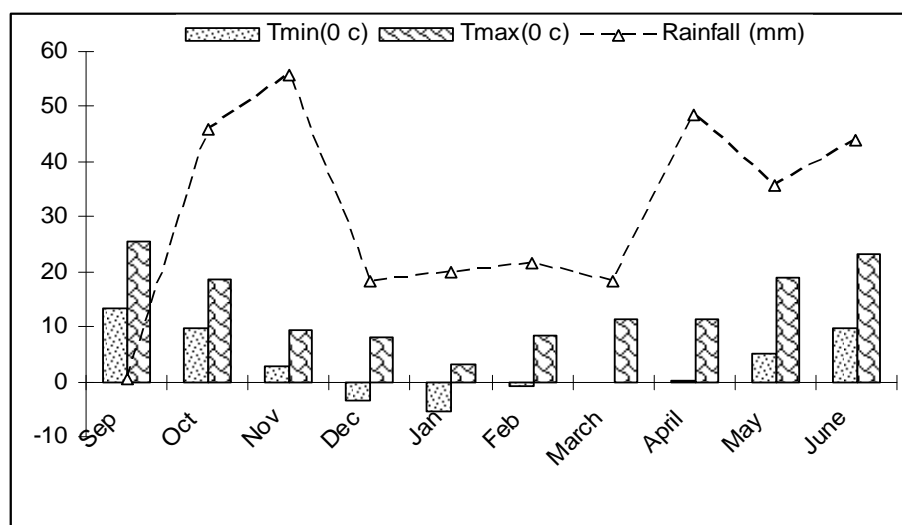


Fig. 1: Minimum and maximum temperatures and rainfall recorded during the period of barley growth (September –June) in 2008 .

The soil was silty loamy with pH about 7.6. The field was prepared well before sowing by plowing twice with tractor followed planking to make a fine seed bed. Row spacing was 20cm, respectively. In each plot there were 6 rows 6m long. Plots and blocks were separated by .4m unplanted distances. Barley seeds were planted in the third week of September. Fertilizer basic dose of N.P.K at the rate of 90-60-60 $kg\ ha^{-1}$ were applied in the form of urea, triple super phosphate and nitrate potassium. All of phosphor and potassium were applied at the time of sowing. Nitrogen fertilize was applied as 1/3th at sowing, 1/3 th at leaf rosette and 1/3 at flowering. Weeds were controlled manually. All other agronomic operations except those under study were kept normal and uniform for all treatments. For estimation of growth analysis, from .2 m^2 in each plot was sampled randomly in each treatment compound and average for recording the change in dry weight in shoots (above ground). Sampling intervals were fifteen days at different stages of the barley growth (180,194, 208, 222, 236, 250, 264, 278 and 292 days after sowing). For dry weight determination, samples were oven dried at 70° C to constant weight. Leaf area index was determined by dividing leaf area over ground area and was

estimated with using of equation 4. The variances trend of total dry matter (TDM), crop growth rate (CGR) and relative growth rate (RGR) were determined with using of 1-3 equations (Acuqaah, 2002 ; Gupta and Gupta, 2005).

$$TDM = e^{a+bt+ct^2+dt^3} \quad (1)$$

$$RGR = b + 2ct + 3dt^2 \quad (2)$$

$$CGR = (b + 2ct + 3dt^2) \times e^{(a+bt+ct^2+dt^3)} \quad (3)$$

$$LAI = e^{(a+bt+ct^2)} \quad (4)$$

In these equations, t is the intervals of sampling or in the other hand, the beginning and end of the interval sampling and a, b and c are coefficient of equations. Grain yield obtained from 1 m² long from the three middle rows in each plot. Analysis of variance and regression were performed using SAS computer software packages. The main effects and interactions were tested using the LSD test.

RESULTS AND DISCUSSION

Total Dry Matter:

Study of trend of variances total dry matter in treatment compounds barley genotypes × different plant population levels various in figure 2 showed that in all of genotypes, total dry matter increased during plant growth with increasing plant population and reached to a maximum level at 264-278 days after planting, then showed a declining trend at maturity (278-292 DAS). Similar results were also reported by Egly and Guffy (1997). The increase in total dry matter with the increasing of plant population indicates the favorable response of barley genotypes to plant population. It is perhaps related to accelerating the photosynthesis activity that is caused dry matter accumulation increased. Study of total dry matter trends of Liseve genotype in various levels of plant population shows that dry matter increased slowly until 180 days after sowing and then increased rapidly till 180-278 days after sowing. From 278 days after sowing till harvest time, accumulated dry matter decreased due to increasing aging of leaves, decreasing of leaf area index (figure 5). On the other hand, total dry matter in unit of area increased with increasing levels of plant population, as the maximum and the minimum biomass in unit of area obtained from 400 and 500 seeds m², respectively (figure 2). Study the total dry matter in other genotypes (Makoei, Sahand and 4714 line) indicated that in all of genotypes it increased with increasing of plant population and trend of variances were similar to dry matter accumulation in Lisive genotype. Increasing leaf area index is one of the ways of increasing the capture of solar radiation within the canopy and production of dry matter. Hence, the efficiency of the conversion of intercepted solar radiation in to dry matter decrease with decreasing of leaf area index (figure 5). In this study, the maximum value of total dry matter was obtained in the maximum value of leaf area index. It is perhaps related to relationship between leaf area index and total dry matter. Our findings are in agreement with observations made by Winter and Ohlrogg (1993) in corn.

Crop Growth Rate:

Study of trend of variances crop growth rate showed that in all of genotypes, the crop growth rate was low in the beginning of sampling, thereafter increased considerably up to 208-222 days after planting with a peak in 222 days after planting (figure 3), then showed a declining trend at 222-236 days after planting. The increase in CGR with the increasing rate of plant population may be due to accelerating the photosynthesis activity and the positive response of barley to plant population. Similar results were also reported by Jeffrey *et al* (2005). The decrease in crop growth rate towards maturity is due to senescence of leaves and decrease of leaf area index (fig 13,14,15 and 16). Similar results were reported by Egly and Guffy (1997).

Relative Growth Rate:

In the initial stages of the plant growth the ratio between alive and dead tissues is high and almost the entire cells of productive organs are activity engaged in vegetative matter production. In all of treatment compounds, RGR decreased during plant growth with decreasing plant population and reached to a minimum level at 264-278 days after planting (figure 4). The reason of decreasing in RGR

at the final stage can be related to increasing of the dead and woody tissues comparing to the alive and active texture and decrease of leaf area index. Similar observations have been reported by Shukla *et al* (2002) in Indian mustard and Jeffrey *et al* (2005) in corn.

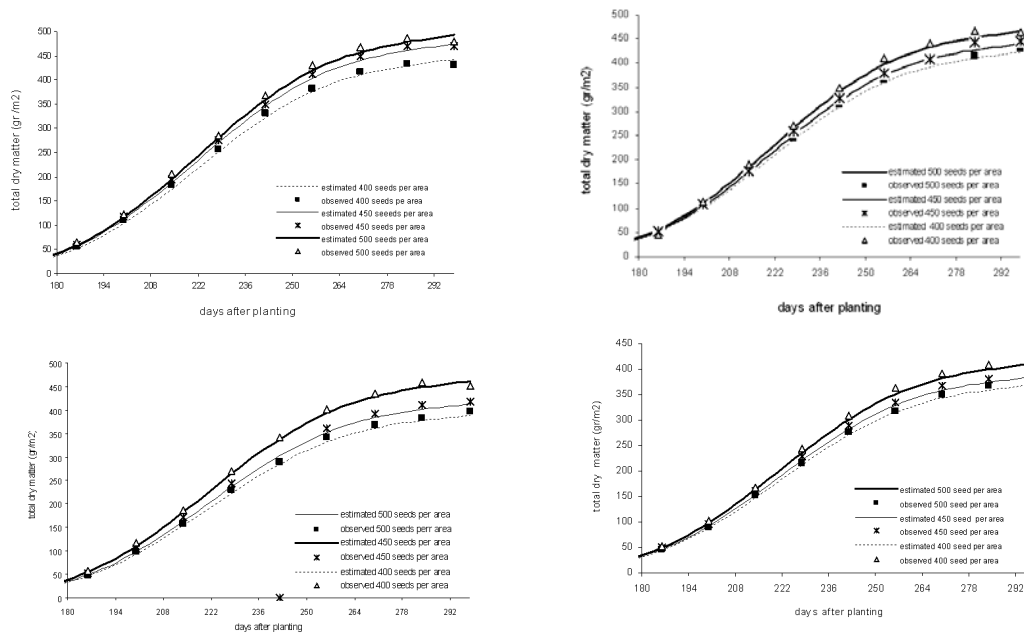


Fig. 2: Process of variance total dry matter in Lesive cultivar (above left), Sahand (above right), Line 4714 (below left) and Makoei (below right) in various levels of plant population.

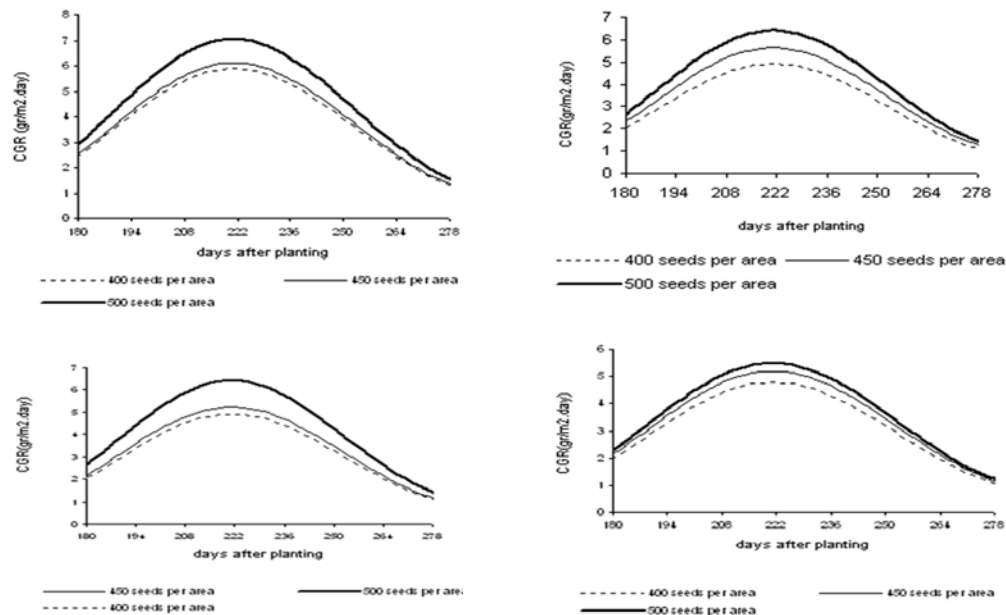


Fig. 3: Process of variance crop growth rate in Lesive cultivar (above left), Sahand (above right), Line 4714 (below left) and Makoei (below right) in various levels of plant population .

Leaf Area Index:

Study of variances trend of leaf area index in figure 5 showed that in all of genotypes, leaf area index increased during plant growth with increasing plant population and reached to a maximum level at 236-250 days after planting. From 250 days after sowing till harvest time, leaf area index decreased due to increasing aging of leaves, shading and competition between plants for light and other resources.

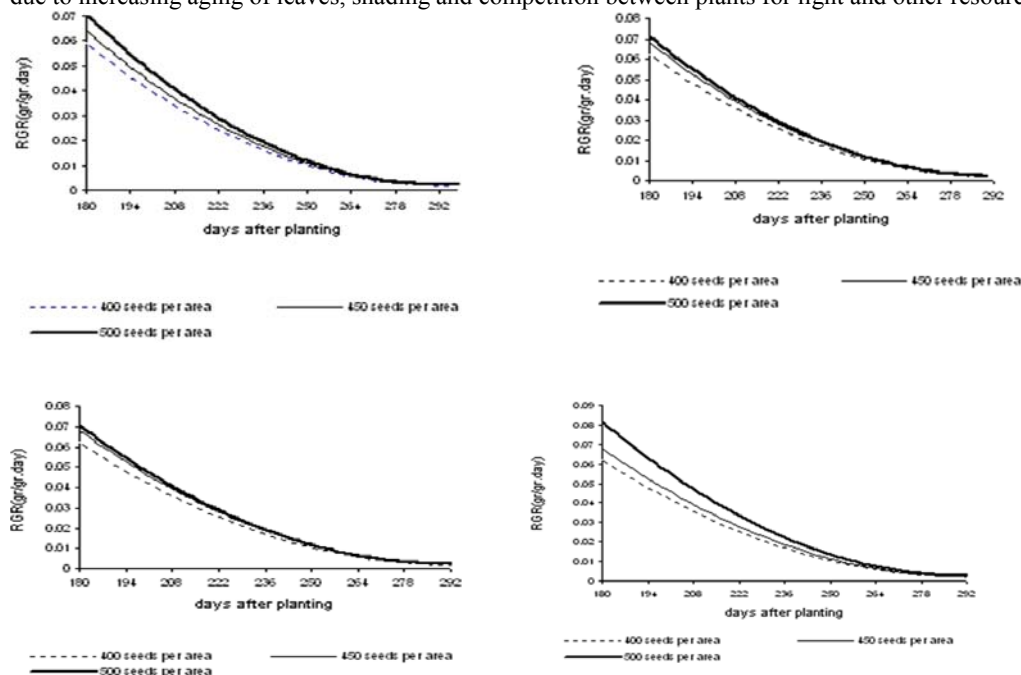


Fig. 4: Process of variance relative growth rate in Lesive cultivar (above left), Sahand (above right), Line 4714 (below left) and Makoei (below right) in various levels of plant population.

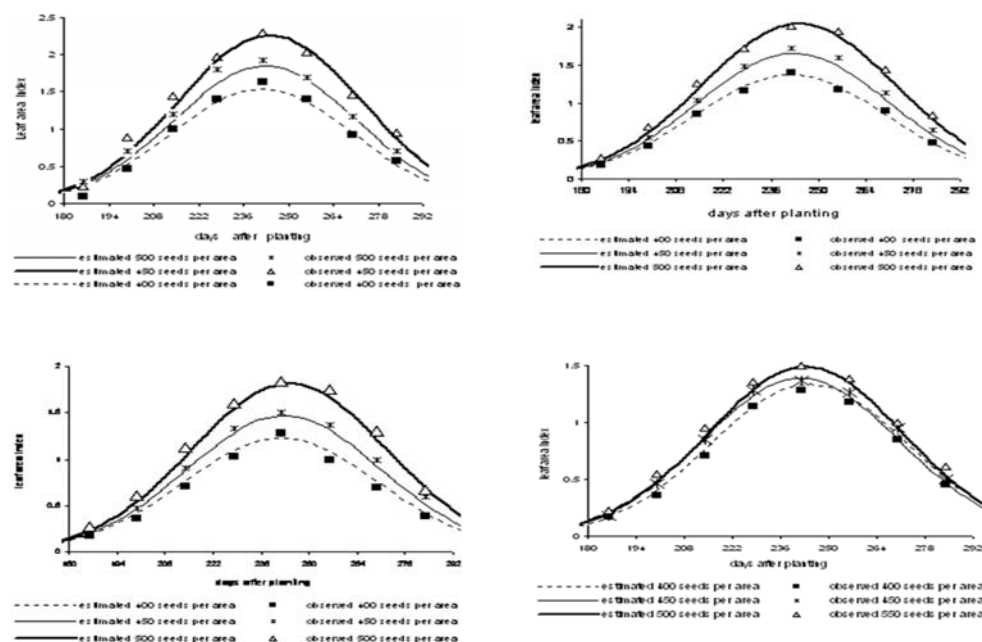


Fig. 5: Process of variance leaf area index in Lesive cultivar (above left), Sahand (above right), Line 4714 (below left) and Makoei (below right) in various levels of plant population.

Increasing leaf area index is one of the ways of increasing the capture of solar radiation within the canopy and production of dry matter. Hence, dry matter produced decreases with decreasing of leaf area index. In the present study, trend of variances leaf area index in treatment compounds of barley

genotypes \times various levels of plant population was according to crop growth rate. These results are in agreement with trend of variances total dry matter. Similar results have also been reported by Faris and De Pauw (1981); Gate (1995); Couvreur *et al* (1999) and Wiersma (2002).

Grain yield: Grain yield is the main target of crop production. The grain yield was significantly affected by both barley genotypes and plant population. Plant density significantly increased the grain yield. The grain yield varied between 1.63 ton/ha in 400 seeds m^{-2} and 1.85 ton/ha in 500 seeds m^{-2} (figure 6). Barley genotypes had difference response to grain yield. The grain yield varied between 1.73 ton/ha in Lsive genotype and 1.35 ton/ha in Makoei genotype (figure 7). Our findings are in agreement with observations made by Wiersma (2002). These results are in agreement with total dry matter and leaf area index. This might be related to correlation between grain yield with total dry matter and leaf area index. Weber *et al* (1966) reported that both total dry matter and leaf area index were poor predictors of grain yield. Winter and Ohlrogge (1993) suggested that grain yield in each of treatment compound is increased when leaf area index and total dry matter increased. In this study, grain yield increased when leaf area index and total dry matter increased.

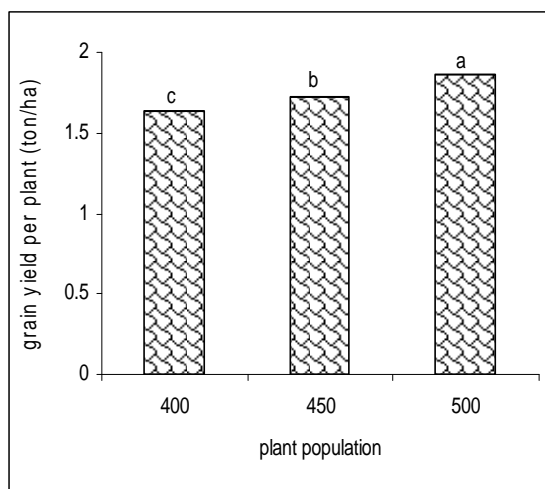


Fig. 6: Mean comparison of grain yield in various levels of plant population.

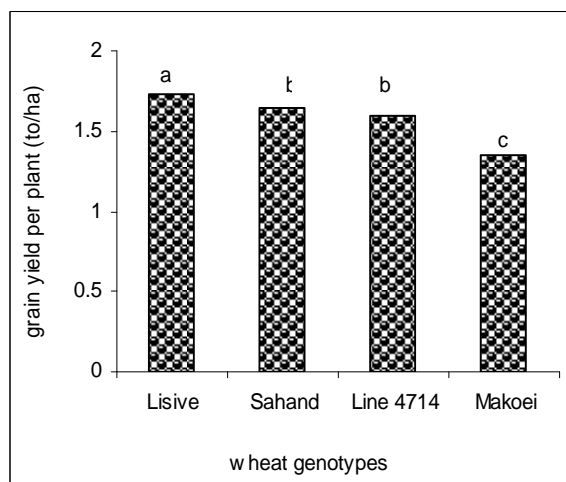


Fig. 7: Mean comparison of grain yield in barley genotypes.

Conclusion:

In this experiment, plant population showed significant effects on barley genotypes yield, and physiological indices of barley such as total dry matter, crop growth rate, relative growth rate and leaf area index. The highest grain yield and physiological indices of barley genotypes recorded in

application of 500 seeds m^{-2} with Liseve genotype. In conclusion, it can be suggested that Liseve genotype should be applied to 500 seeds m^{-2} in conditions of Ardabil Plain.

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